The El Trébol Landfill Landfill Gas Pre-Feasibility Study: Landfill Gas Model Development

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Presentation Topics

- International LFG modeling overview
- Landfill history
- Waste disposal estimates
- Waste composition
- Model inputs – k and Lo values
- Future collection system coverage
- Model results

International LFG Modeling Overview

- **Good estimates of LFG recovery needed to evaluate project design, size, feasibility and economics**
- **Use EPA's LandGEM first-order decay model**

$$\sum_{i=1}^{n} 2\,k\,L_0\,M\,e^{-kt_i}$$

where:

k = refuse decay rate (1/yr)

L_0 = methane generation potential (m^3/tonne)

M = mass of waste deposited (tonnes) in year “i”

t_i = age of waste (years) in year “i”

International LFG Modeling Overview (cont.)

- Revise model to project LFG recovery, not generation
- Need modifications to account for Guatemala differences with U.S. waste composition, climate, and landfill design
- Project LFG recovery given estimated limitations of future gas collection system

Landfill History

- Landfill is canyon fill ~100-250 m wide and 100 m deep
- No disposal records; Parsons report to the U.S. DOE in 1999 is best source of disposal information
- Canyon used as historical disposal site
- Upper portions of canyon filled before 1966 were closed and developed as a soccer field
- Landfill has extended 650 m down the canyon since 1966 and covered 16.2 hectares
- Lower 200 m of landfill below service road is active disposal area

Waste Disposal Estimates

- **Parsons Report developed disposal estimates based on waste volumes and the following considerations:**
  - A large portion of waste consists of construction debris
  - In 1998 Hurricane Mitch caused a large landslide that washed 1 million m^3 of landfill material down the canyon
  - Disposed waste contains a very high moisture content

Waste Disposal Estimates (cont.)

- **Estimated waste in place as of 1/1/2005:**
  - 8.3 million tons of municipal solid waste (MSW), converted to 3.87 million tons after adjusting to 20% moisture (typical U.S. waste moisture)
  - C&D waste total = 2.33 million tons
  - Total = 6.2 million tons

Waste Disposal Estimates (cont.)

- **Future disposal estimates:**
  - Assume MSW will grow at historic rate of 3.35%/year
  - Assume construction waste will grow at historic rate of 2.5%/year
  - No estimates of site capacity; site managers estimate at least 10 years of site life remain.
  - Landfill drawing indicates ~40% of site filled by 1999; implies total capacity of 11.4 million tons
  - Capacity and growth rates imply closure date of late 2018

Waste Disposal Estimates (cont.)

- **Estimated waste available for LFG production – subtract from total for model inputs**
  - Parsons Report excluded wastes disposed before 1985 since little LFG will be left from older wastes
  - 40%-50% of waste disposed in 1985-88 is unavailable due to housing development on disposal areas
  - 100% of waste disposed in 1989, 1997, and 1998 washed down the canyon during landslide events in 1989 and 1998
  - Construction debris subtracted out since it contributes little LFG
  - Results: 2,195,500 tons (78% of total) of MSW available as of 1/1/2005 for LFG production

Waste Composition

- **Waste organic content, moisture content, and "degradability" impacts LFG production rates**
  - Food waste = 37.8% (fast decay rate)
  - Green waste = 12.6% (mix of fast and medium decay)
  - Paper and cardboard = 18.1% (medium decay)
  - Leather, textiles, bones = 4.8% (slow decay)
  - Inert materials include: plastics (10.1%); metals (2.2%); glass (1.6); ash, tile, other construction debris (6.1%); other inorganic waste (6.7%)

*Waste composition %s assigned based on 1998 waste composition data for Guatemala

Waste Composition (cont.)

- **El Trébol Landfill contains much more food waste than U.S. landfills**
  - Food and green waste decay rapidly and produce LFG sooner, but over a shorter length of time. This effect is reflected in the model refuse decay rate, k.
  - Higher organic fraction and moisture content of wastes at El Trébol affect the total amount of LFG produced.
    - **Higher organic % increases LFG production.**
    - **Higher moisture content decreases LFG production (per unit weight of MSW) since water is inert.**
    - **These effects are reflected in the model methane recovery capacity, Lo.**

Developing the Guatemala L_0 Value

- **Start with the U.S. EPA estimate for L_0 = 100 m^3/tonne for LFG generation in U.S. landfills**
- **Adjust to convert to LFG recovery by multiplying by estimated maximum collection efficiency (85%) – recovery L_0 for U.S. landfills = 85 m^3/tonne**
- **To derive Guatemala L_0 value, adjust for differences in organic and moisture content**
  - Higher % of organic waste – increases L_0
  - Higher % of moisture – decreases L_0 (no change since MSW tons already adjusted)
- **Result: Guatemala L_0 = 91.4 m^3/tonne**

Developing the Guatemala k Value

- **Unlike the L_0, the k value cannot be estimated by comparing waste %s**
- **Can develop composite model for estimating LFG production from fast, medium, and slowly decaying waste, using the following steps:**

1. Assume fast, medium, and slow waste components' decay rates have a fixed ratio of 20:4:1 (based on lab research)
2. Assign single k value for a U.S. site with 119 cm of rainfall (amount at Guatemala City) = 0.065/year
3. Adjust fast, medium and slow waste component k values so that 3-k model best matches results of 1-k model
4. Use k values in 3-k model for El Trébol

Developing the Guatemala k Value (cont.)

- **Resulting k values:**
  - Fast-decaying waste = 0.22/year
  - Medium-decaying waste = 0.044/year
  - Slowly-decaying waste = 0.011 per year

Collection System Coverage Estimates

- **Model application using the disposal estimates and k and L_0 values assigned estimates "potential" LFG recovery without accounting for limitations of collection system**
- **Realistic estimates of recovery achievable with collection system: 60% while the site is open, 70% after closure**
  - High moisture content and leachate levels limit system effectiveness
  - Need for ongoing system adjustment, maintenance, and expansion into new disposal areas

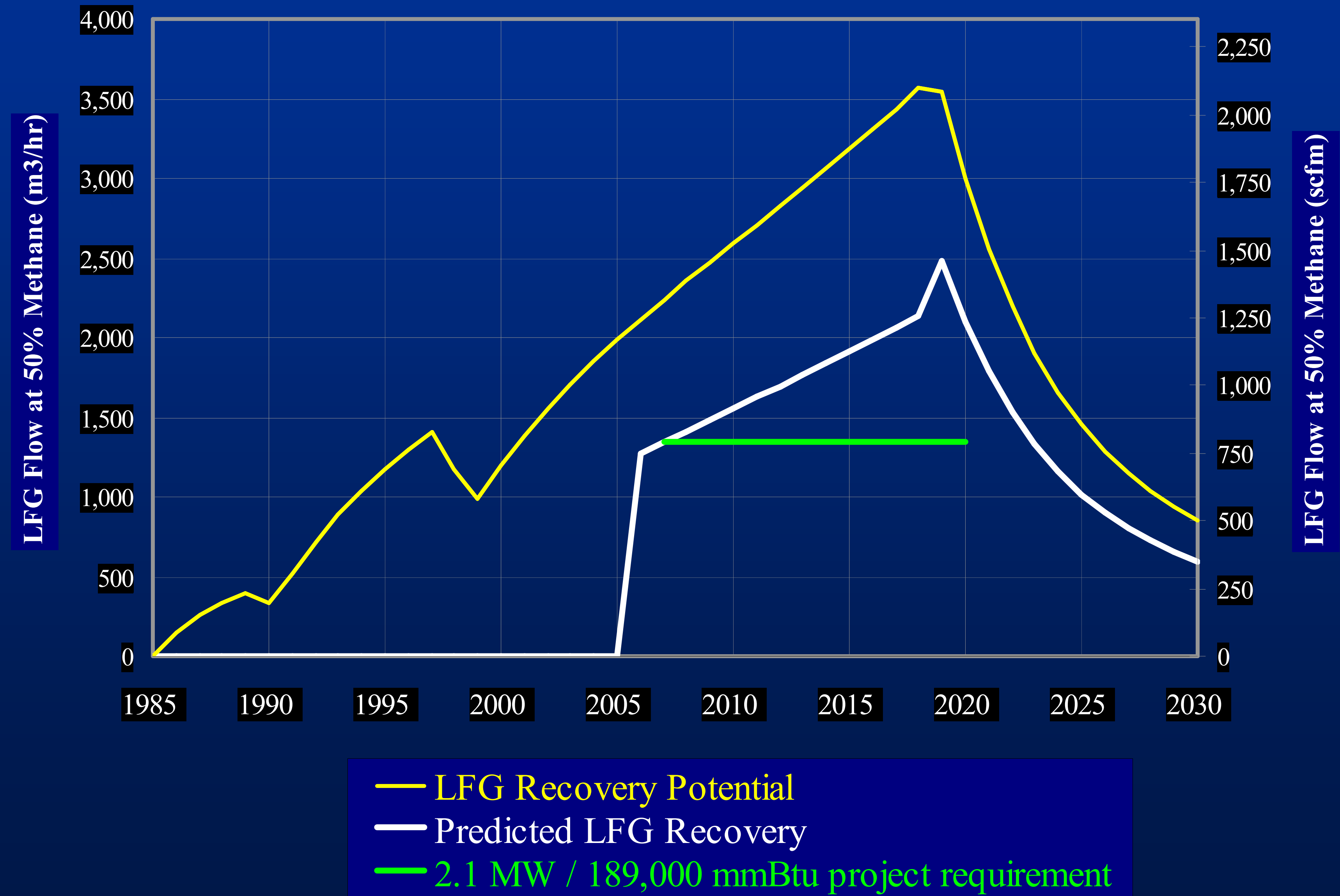
Landfill Gas Modeling Results

- **Develop current LFG recovery potential estimate from model for comparison to pump test results**
  - 2005: Model predicts 1,167 ft^3/minute (1,983 m^3/hour)
  - This estimate is 37 ft^3/minute or 3% higher than pump test based estimate of 1,130 ft^3/minute
  - 3% error is within precision level of pump test
  - Conclude that pump test generally supports model results
- **Future potential LFG recovery estimates:**
  - 2006: 1,243 ft^3/minute (2,111 m^3/hour)
  - 2018: 2,100 ft^3/minute (3,568 m^3/hour) = maximum
  - Declines after site closure in 2018.

Landfill Gas Modeling Results (cont.)

- **Expected LFG recovery after accounting for collection system coverage**
  - Model assumes that LFG collection will begin in 2006.
  - 2006: 746 ft^3/minute (1,267 m^3/hour)
  - 2012: 997 ft^3/minute (1,695 m^3/hour)
  - 2019: 1,461 ft^3/minute (2,482 m^3/hour) = maximum
  - Declines after 2019
- **Projected recovery is sufficient for:**
  - 2 MW power plant initially; larger plant in later years
  - Approximately 200,000 mmBtus/year direct use project

Landfill Gas Curve



Questions?

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